

ELECTRICITY AND MAGNETISM: LABORATORY–INTRODUCTION

Electricity and magnetism are two most important components of physics that find numerous applications in our daily life. They can range from a small electromagnet fitted in a door bell to a big magnet used for bending the path of electrons in a sophisticated synchrotron radiation source used to perform advanced physics experiments. In the theory course entitled Electricity and Magnetism (BPHCT-133), you have learnt about the laws governing electrostatics and magnetostatics as well as electromagnetic induction, Maxwell's equations and electromagnetic waves. In this laboratory course you will get an opportunity to apply these theoretical aspects in some practical situations.

You will be performing a wide range of experiments in this course. To begin with, in Experiment 1, we will familiarise you with a Multimeter, which is one of the most versatile measuring instrument used in a physics laboratory. You will learn how to measure ac/dc voltages, and currents as well as resistances using multimeter.

In Experiment 2, you will learn the effect of magnetic induction in magnetising a ferromagnetic specimen. You will also be able to determine its magnetic parameters like coercivity and retentivity.

In electrical circuits, resistors, capacitors and inductors are the main passive elements used for different applications. Resistors are basically dissipative in nature and used for controlling the current flowing through the circuit. But when combined with capacitor and/or inductor it can give some wonderful results. Combinations of resistors and capacitors can be used as filters for removing certain frequency bands from the input signal. A capacitor has the property of storing charge and can be used as a source of energy, when the external power source is absent. To understand this application of capacitors and properly design a circuit comprising R and C , in Experiment 3, you will learn the capacitor charging/discharging process. You will be able to choose proper values of R and C depending on the frequency of operation of your circuit.

A combination of L , C and R gives rise to resonant circuits with extremely good frequency selectivity in the vicinity of resonant frequency. You will study the frequency response of series combination of L , C and R in Experiment 4. You will determine the resonant frequency as well as bandwidth of this circuit. You will also study the effect of R on the sharpness of frequency selection.

In Experiment 5, you will connect L , C and R in parallel combination. Here, you will find out that the practical inductor is not an ideal component, but a combination of L and a series resistance arising due to the wire used for winding the inductor coil. You will study the effect of resistance in the circuit in determining the resonant frequency of the parallel LCR circuit.

Precise measurement of component values is a challenging task, especially when their values are extremely low. This is because in such cases, the impedances offered by the measuring instruments also start becoming significant and affect the measurements. One such difficult problem is to measure ultra-low resistance values ($< 0.1 \Omega$). For this purpose you will learn how to use a bridge method (null-method) in Experiment 6. You will set up the Carey Foster bridge apparatus and take measurements of low resistances in this experiment.

When we build any electrical circuit using several passive components and an energy source, it is quite cumbersome to determine the currents in its various branches and voltages at different points. However, there are some network theorems that come in handy in analysing the circuits. Any complicated network (circuit) having components and energy sources can be simplified using Thevenin and Norton's theorems. In Experiment 7 you will build the circuits and verify these two theorems.

Estimation of power transferred by a circuit to its load can be worked out on the basis of impedance values of the source and load. Maximum power is transferred when moduli of these two impedances are equal. This is established through maximum power transfer theorem. Estimation of voltage across a component or current through a branch in a circuit with multiple energy sources can be done by superposing the contributions from individual sources at any given time. This can be established through superposition theorem. You will verify both these theorems in Experiment 8.

Diode is an important circuit element made of semiconductors. The current through a diode varies depending on the polarity of voltages applied across it. This property paves the way for various applications of diodes in a circuit.

In Experiment 9 you will study the current-voltage characteristics of a p - n junction diode and in Experiment 10 you will build a circuit using diodes to obtain rectified voltage. You will also investigate the role of R - C , R - L and L - C filters in obtaining the desired dc output.

With this wide range of experiments, you will get a glimpse of various electrical and magnetic phenomena and their applications in daily life. We are sure that you will have fruitful laboratory sessions with good understanding of various aspects of electricity and magnetism.

We hope you enjoy doing the experiments and develop a good understanding of related phenomena. We wish you success in this laboratory course.